

Dust Sourced in The Arctic Region: Characteristics, Importance and New Challenges

Santiago Gassó

ESSIC/UMD/GSFC

sgasso@umd.edu ,  @SanGasso

#highlatitudedust

4th Changes in the Arctic Boreal System (CABS)

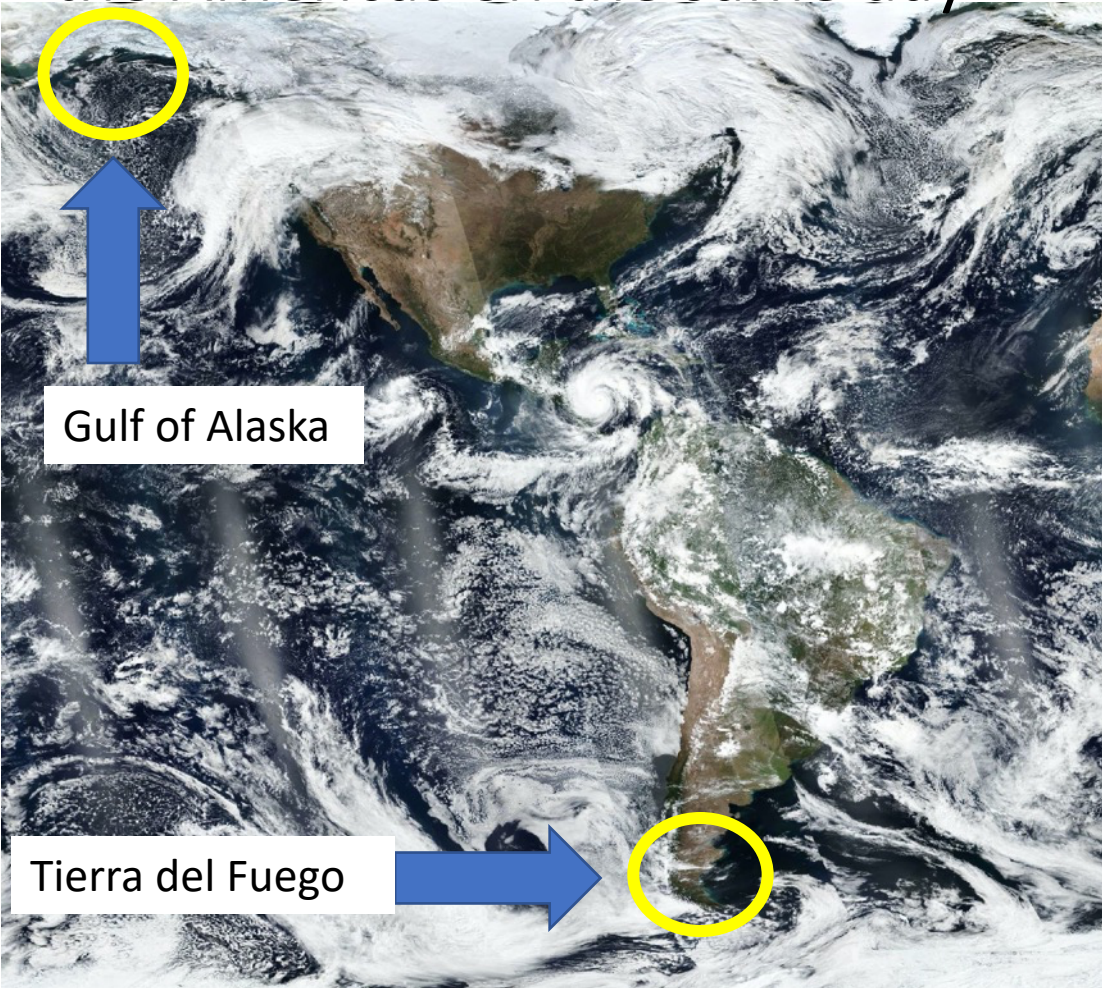
Quarterly Update

February 2, 2021



Nov/16/2020 - a generally unremarkable day except.....

Dust Activity in both ends of the Americas on the same day



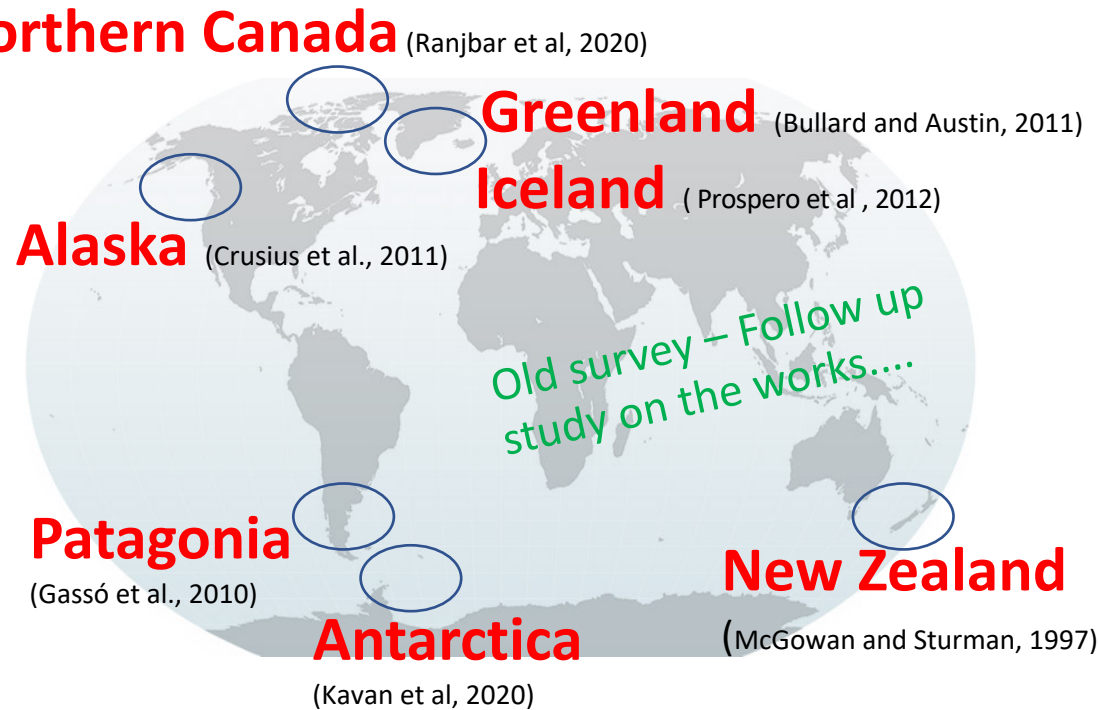
Nov/16/2020

60 deg N

Resuspended Glacier Silt, Copper River Delta



High latitude dust (HLD) refers to aeolian material (such as glacier silt, volcanic ash) emitted from sources $\geq 50^{\circ}\text{N}$ and $\geq 40^{\circ}\text{S}$.



Reviews of Geophysics

Review Article | [Open Access](#) |

High-latitude dust in the Earth system

Joanna E. Bullard , Matthew Baddock, Tom Bradwell, John Crusius, Eleanor Darlington, Diego Gaiero, Santiago Gassó, Gudrun Gisladdottir, Richard Hodgkins, Robert McCulloch ... [See all authors](#)

First published: 23 May 2016 | <https://doi.org/10.1002/2016RG000518> | Citations: 82

<https://doi.org/10.1002/2016RG000518>

From what we already know, HLD is not a major player in the modern radiative balance of the atmosphere (aerosol direct effect)

However, there are other reasons why we should pay attention to it.

But first , a few close ups of High Latitude Dust

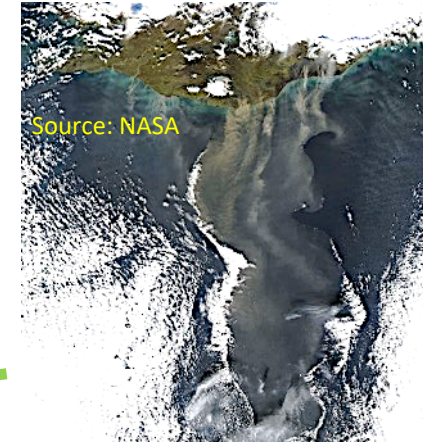
Baffin Island, Canada (~70 N)



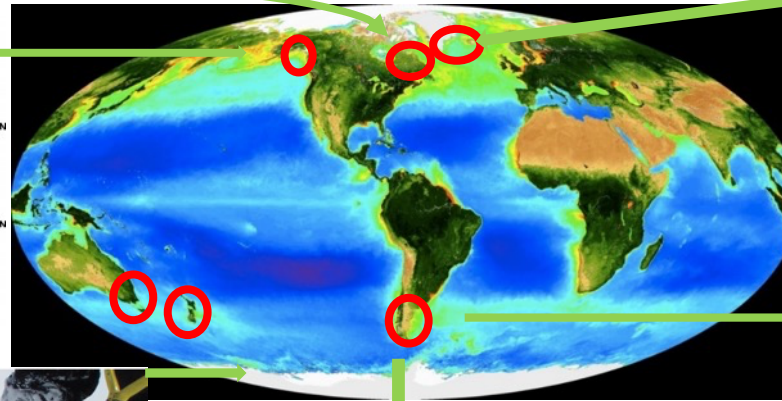
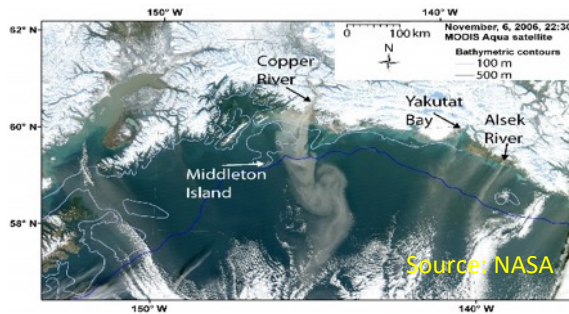
Kangerlussuaq, Greenland (~64 N)



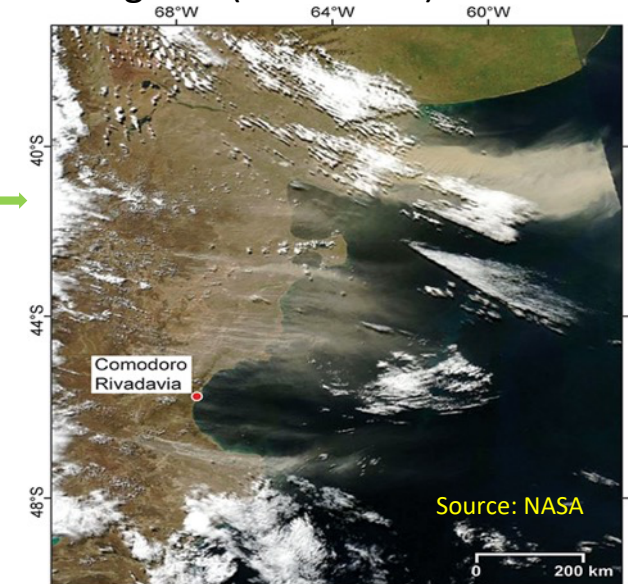
Iceland (64 N)



Gulf of Alaska (60 N)



Patagonia (40S to 53S)



Dry Valleys near
McMurdo,
Antarctica (75S)

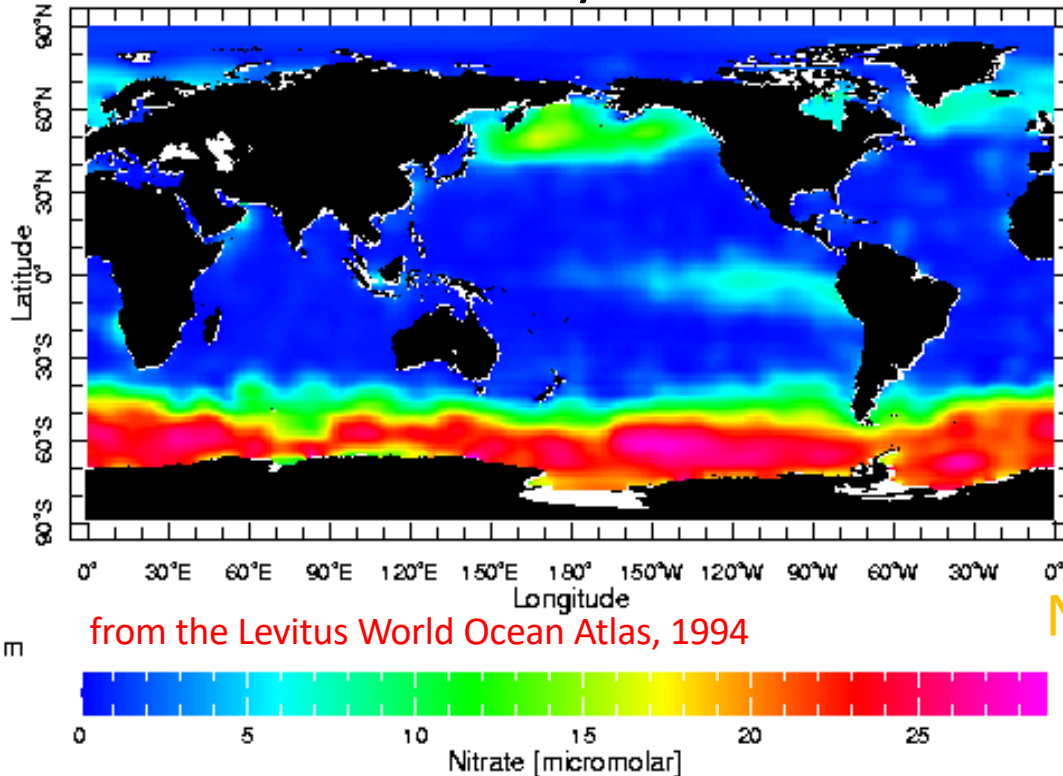


Tierra del Fuego (54S)

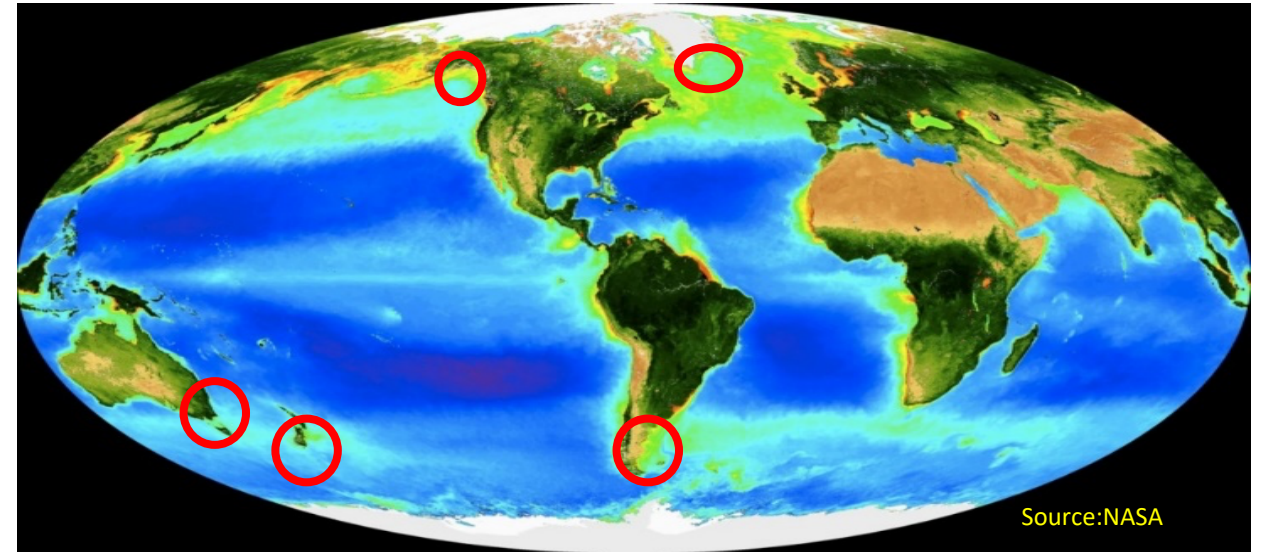


Reason 1: Nutrients for Ecosystems (I)

Nitrate availability in the Ocean



Ocean Chlorophyll as indicator of PP



Nitrate, a major nutrient, is plenty in many areas with little biological activity (Southern Ocean, N Pacific).

Why is it not consumed?

Deficit of Iron, a key micronutrient, is the reason.

Can iron in dust modulate marine ecosystems primary production?

Reason 1: Nutrients for Ecosystems (II)

Article | [Open Access](#) | Published: 25 January 2021

Mineral phosphorus drives glacier algal blooms on the Greenland Ice Sheet

Jenine McCutcheon  orcid.org/0000-0002-9114-7408^{1,2}, Stefanie Lutz³, Christopher Williamson^{4,5}, Joseph M. Cook⁶, Andrew J. Tedstone⁴, Aubry Vanderstraeten⁷, Siobhan A. Wilson orcid.org/0000-0002-0858-6902⁸, Anthony Stockdale orcid.org/0000-0002-1603-0103¹, Steeve Bonneville orcid.org/0000-0001-7523-8222⁷, Alexandre M. Anesio orcid.org/0000-0003-2990-4014⁹, Marian L. Yallop⁵, James B. McQuaid orcid.org/0000-0001-8702-0415¹, Martyn Tranter orcid.org/0000-0003-2071-3094^{4,9} & Liane G. Benning orcid.org/0000-0001-9972-5578^{1,3,10}

Nature Communications **12**, Article number: 570 (2021) | [Cite this article](#)

1837 Accesses | 176 Altmetric | [Metrics](#)

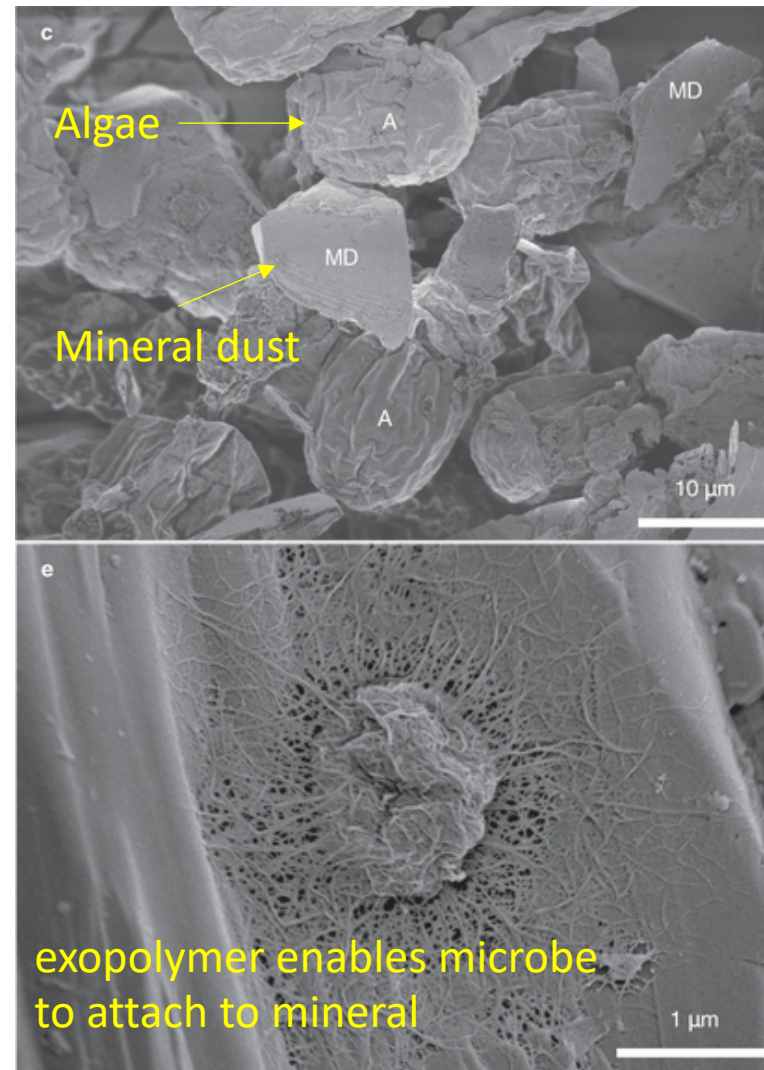
Subjects

Element cycles

Abstract

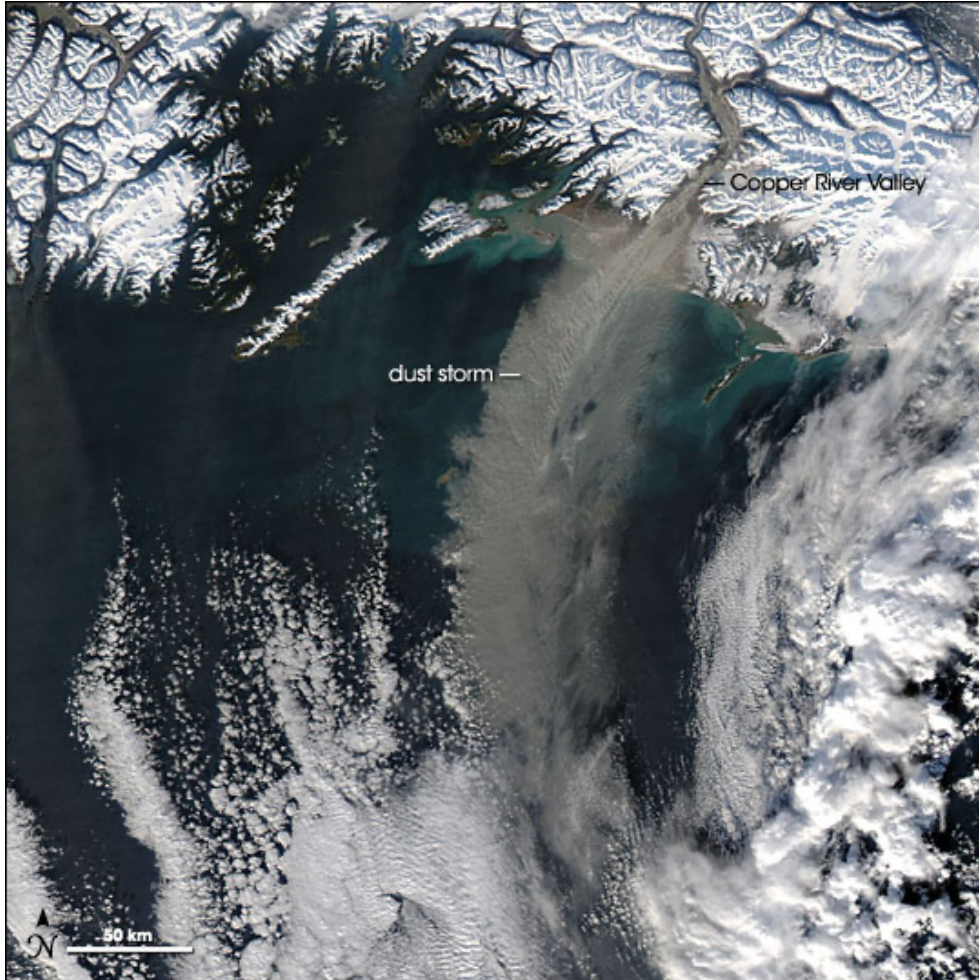
Melting of the Greenland Ice Sheet is a leading cause of land-ice mass loss and cryosphere-attributed sea level rise. Blooms of pigmented glacier ice algae lower ice albedo and accelerate surface melting in the ice sheet's southwest sector. Although glacier ice algae cause up to 13% of the surface melting in this region, the controls on bloom development remain poorly understood. Here we show a direct link between mineral phosphorus in surface ice and glacier ice algae biomass through the quantification of solid and fluid phase phosphorus reservoirs in surface habitats across the southwest ablation zone of the ice sheet. We demonstrate that nutrients from mineral dust likely drive glacier ice algal growth, and thereby identify mineral dust as a secondary control on ice sheet melting.

<https://www.nature.com/articles/s41467-020-20627-w>



Dust drives
algal growth
in Greenland
ice

Reason 2: Dust as condensation nuclei for Arctic clouds



<https://earthobservatory.nasa.gov/images/6003/dust-storm-off-alaska>



Glacially sourced dust as a potentially significant source of ice nucleating particles

Yutaka Tobo^{1,2*}, Kouji Adachi³, Paul J. DeMott⁴, Thomas C. J. Hill⁴, Douglas S. Hamilton⁵, Natalie M. Mahowald⁵, Naoko Nagatsuka¹, Sho Ohata^{6,7,8}, Jun Uetake^{1,4}, Yutaka Kondo¹ and Makoto Koike⁶

Nature Geoscience | APRIL 2019 | <https://www.nature.com/articles/s41561-019-0314-x>

RESEARCH ARTICLE | ATMOSPHERIC SCIENCE

Iceland is an episodic source of atmospheric ice-nucleating particles relevant for mixed-phase clouds

A. Sanchez-Marroquin^{1,*}, O. Arnalds², K. J. Baustian-Dorsi^{1,3}, J. Browse¹...

Science Advances 24 Jun 2020: Vol. 6, no. 26, eaba8137 DOI: 10.1126/sciadv.aba8137

Reason 3 : Dust as a Tracer of Climate dynamics

ARTICLE

<https://doi.org/10.1038/s41467-019-12546-2>

OPEN

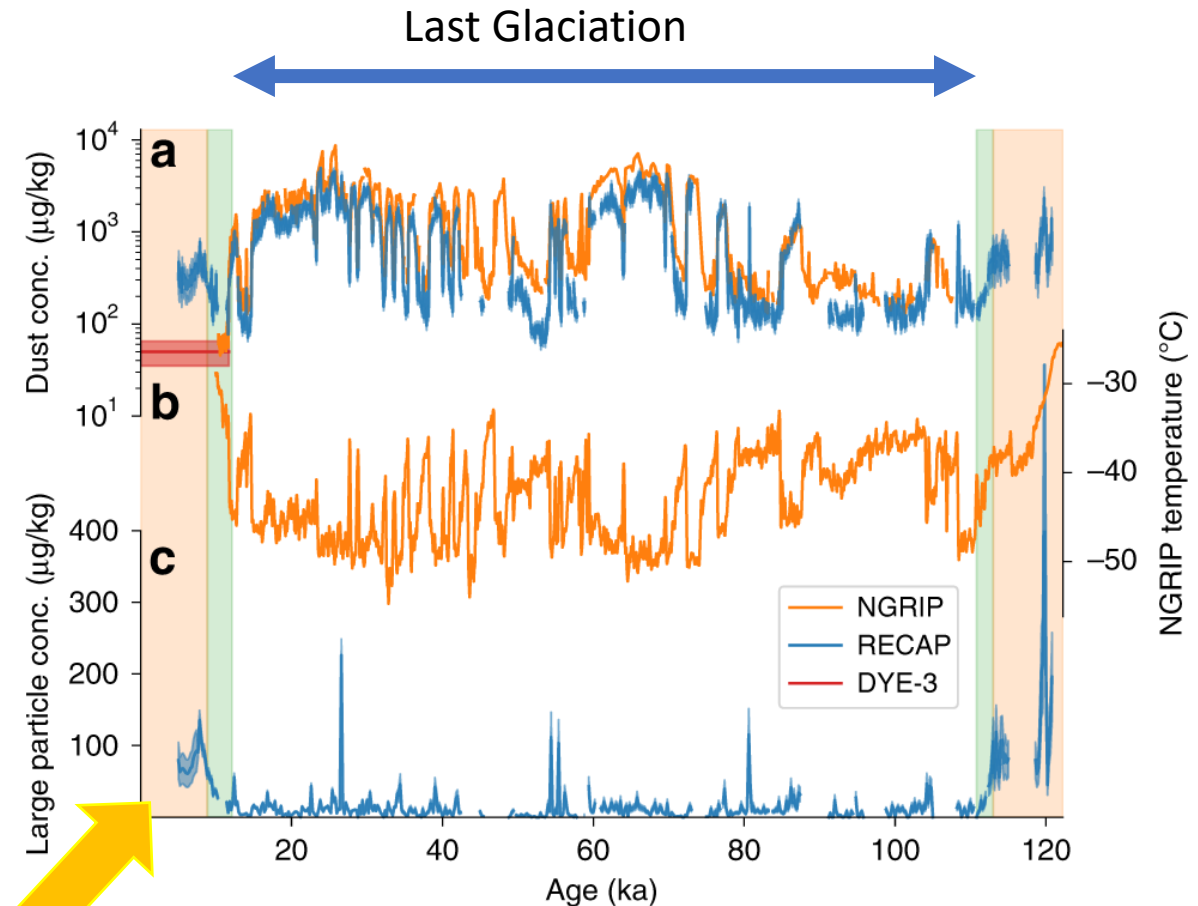
East Greenland ice core dust record reveals timing of Greenland ice sheet advance and retreat

Marius Folden Simonsen¹, Giovanni Baccolo², Thomas Blunier¹, Alejandra Borunda^{3,4}, Barbara Delmonte², Robert Frei⁵, Steven Goldstein^{3,4}, Aslak Grinsted¹, Helle Astrid Kjær¹, Todd Sowers⁶, Anders Svensson¹, Bo Vinther¹, Diana Vladimirova¹, Gisela Winckler^{3,4}, Mai Winstrup¹ & Paul Vallelonga^{1*}

03 October 2019, <https://www.nature.com/articles/s41467-019-12546-2>

Accurate estimates of the past extent of the Greenland ice sheet provide critical constraints for ice sheet models used to determine Greenland's response to climate forcing and contribution to global sea level. Here we use a continuous ice core dust record from the Renland ice cap on the east coast of Greenland to constrain the timing of changes to the ice sheet margin and relative sea level over the last glacial cycle. During the Holocene and the previous interglacial period (Eemian) the dust record was dominated by coarse particles consistent with rock samples from central East Greenland. From the coarse particle concentration record we infer the East Greenland ice sheet margin advanced from 113.4 ± 0.4 to 111.0 ± 0.4 ka BP during the glacial onset and retreated from 12.1 ± 0.1 to 9.0 ± 0.1 ka BP during the last deglaciation. These findings constrain the possible response of the Greenland ice sheet to climate forcings.

Much of our understanding of paleo-atmosphere dynamics comes from dust in ice-cores



Lots of Coarse Particles → short transport time → indicative of local sources

Reason 4 : Dust darkens ice/snow surfaces

Well documented cases with confirmed impact in melting rates



Remote Sensing of Environment

Volume 233, November 2019, 111396



Persistent albedo reduction on southern Icelandic glaciers due to ashfall from the 2010 Eyjafjallajökull eruption

Rebecca Möller ^{a, b, ✉}, Pavla Dagsson-Waldhauserova ^{c, d}, Marco Möller ^{a, f}, Peter A. Kukla ^b, Christoph Schneider ^f, Magnús T. Gudmundsson ^g

<https://www.sciencedirect.com/science/article/pii/S0034425719304158>

The Cryosphere, 11, 741–754, 2017
<https://doi.org/10.5194/tc-11-741-2017>
© Author(s) 2017. This work is distributed under the Creative Commons Attribution 3.0 License.



Research article

23 Mar 2017

Impact of dust deposition on the albedo of Vatnajökull ice cap, Iceland

Monika Wittmann¹, Christine Dorothea Groot Zwaaftink², Louise Steffensen Schmidt¹, Sverrir Guðmundsson^{1,3}, Finnur Pálsson¹, Olafur Arnalds⁴, Helgi Björnsson¹, Throstr Thorsteinsson¹, and Andreas Stohl²

¹Institute of Earth Sciences, University of Iceland, Reykjavik, Iceland

²NILU – Norwegian Institute for Air Research, Kjeller, Norway

³Keilir, Institute of Technology, Reykjanesbær, Iceland

⁴Agricultural University of Iceland, Hvanneyri, Iceland

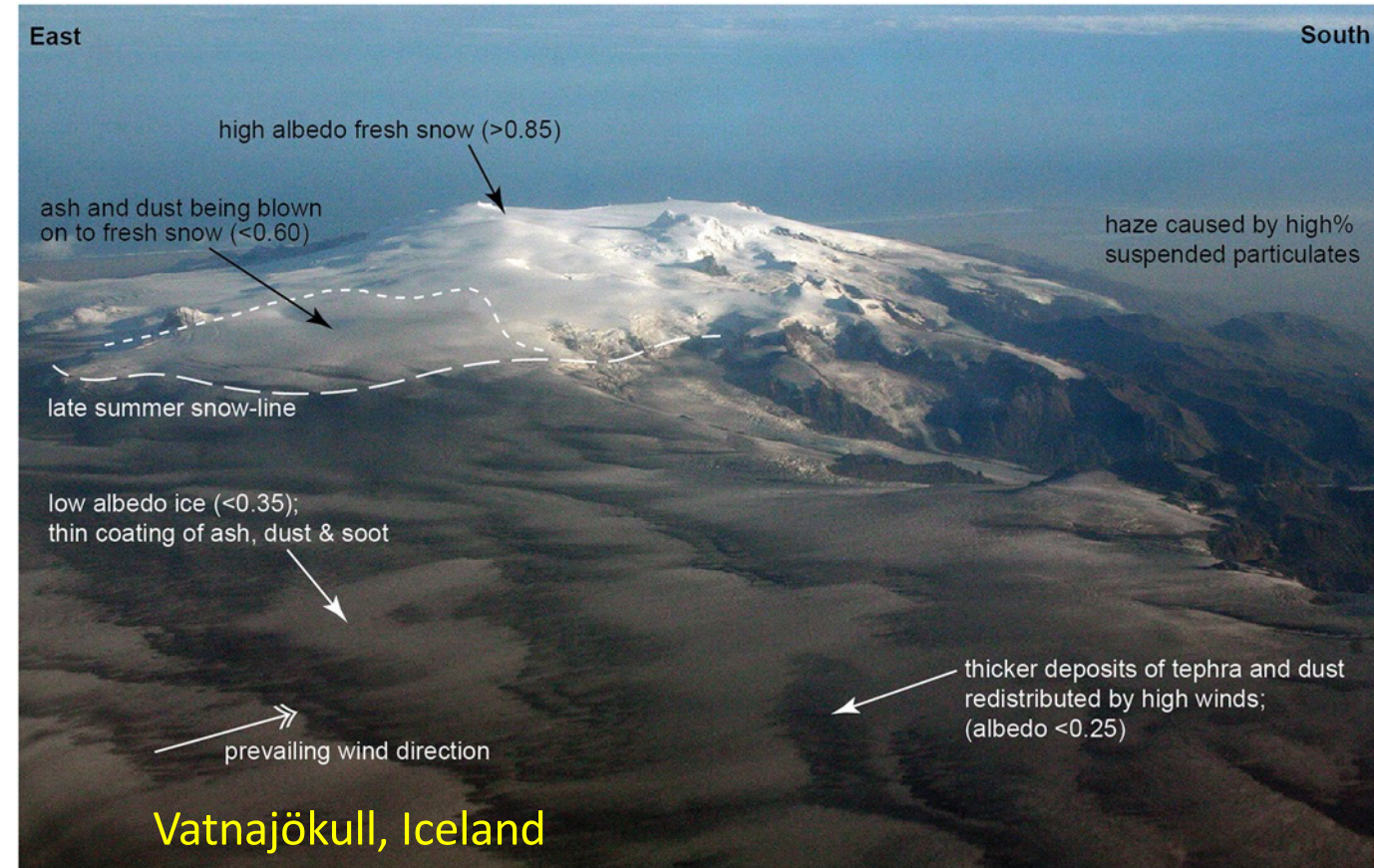
Article

Peer review

Metrics

Related articles

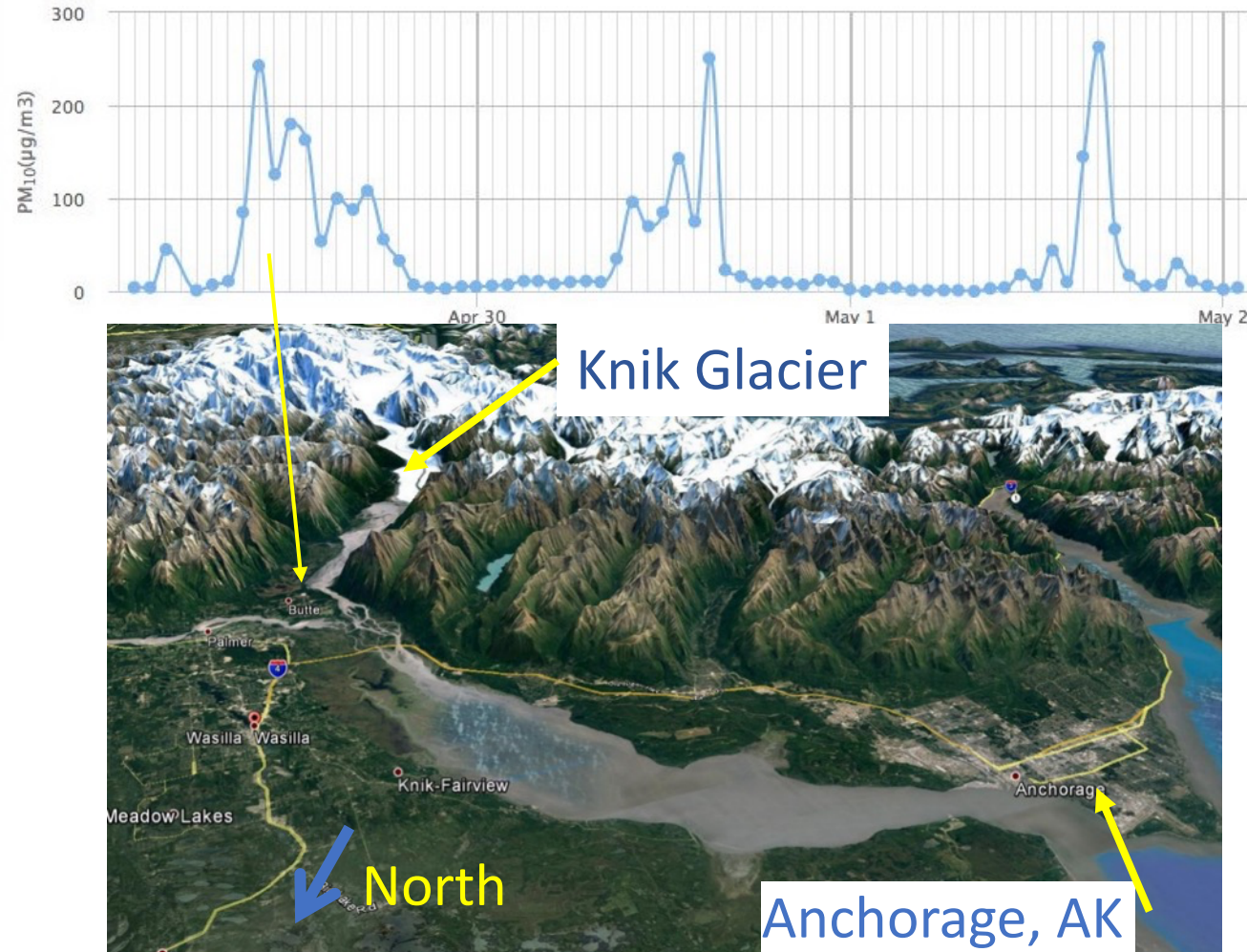
<https://doi.org/10.5194/tc-11-741-2017>, 2017.



<https://doi.org/10.1002/2016RG000518>

Reason 5 : Air Quality in Alaska

Large and Frequent PM exceedances in Butte (near Anchorage)



MATANUSKA-SUSITNA BOROUGH

Planning and Land Use Department

Planning Division

350 East Dahlia Avenue • Palmer, AK 99645

planning@matsugov.us

AIR QUALITY ADVISORY/PRESS RELEASE

The Matanuska-Susitna Borough is issuing an air quality advisory for the Mat-Su Core Area, including the Cities of Palmer and Wasilla, and surrounding Communities, valid from 1:00pm, Wednesday April 3, 2019 until the winds subside. With the increasing winds and gusts the Mat-Su Core Area, including the Cities of Palmer and Wasilla, and surrounding Communities may have areas of blowing dust. The Air Quality in these areas may become unhealthy.

WHEN BLOWING DUST IS VISIBLE CHILDREN, THE ELDERLY, AND PERSONS WITH EXISTING HEART OR LUNG DISEASE, SHOULD STAY INDOORS AND REDUCE PHYSICAL ACTIVITY. THE GENERAL POPULATIONS SHOULD AVOID VIGOROUS OUTDOOR ACTIVITY.

Please call the 24-hour Air Quality Alert System phone number, 352-3878, for information on air quality in the eastern Matanuska Valley. This advisory will expire 12:00pm Thursday, April 4, 2019, or be updated if conditions change.

If you have any questions, please call the Matanuska-Susitna Borough Planning Division at 861-7833.

Eileen Probasco, Director of Planning and Land Use

April 3, 2019

Reasons 5 : Air Quality - International

Dust and volcanic ash resuspension is an Air Quality concern in Iceland

Open Access Article

Emergency Hospital Visits in Association with Volcanic Ash, Dust Storms and Other Sources of Ambient Particles: A Time-Series Study in Reykjavík, Iceland

by  Hanne Krage Carlsen ^{1,2,*},  Thorarinn Gislason ^{3,4},  Bertil Forsberg ²,  Kadri Meister ²,  Throstur Thorsteinsson ^{5,6},  Thorsteinn Jóhannsson ⁷,  Ragnhildur Finnbjörnsdóttir ¹ and  Anna Oudín ²

¹ Centre of Public Health Sciences, University of Iceland, Stapi v/Hringbraut, 101 Reykjavík, Iceland

² Unit of Occupational and Environmental Medicine, Department of Public Health and Clinical Medicine, Umeå University, 90187 Umeå, Sweden

³ Department of Respiratory Medicine and Sleep, Landspítali University Hospital-Fossvogur, 108 Reykjavík, Iceland

⁴ Faculty of Medicine, School of Health Sciences, University of Iceland, Vatnsmýrarveg 16, 101 Reykjavík, Iceland

⁵ Unit of Environment and Natural Resources, University of Iceland, Sturlugata 7, 101 Reykjavík, Iceland

⁶ Institute of Earth Sciences, School of Engineering and Natural Sciences, University of Iceland, Sturlugata 7, 101 Reykjavík, Iceland

⁷ Environmental Agency of Iceland, Suðurlandsbraut 24, 108 Reykjavík, Iceland

* Author to whom correspondence should be addressed.

Academic Editor: Paul B. Tchounwou

Int. J. Environ. Res. Public Health **2015**, *12*(4), 4047–4059; <https://doi.org/10.3390/ijerph120404047>

Received: 21 January 2015 / Revised: 17 March 2015 / Accepted: 2 April 2015 / Published: 13 April 2015

[View Full-Text](#)

[Download PDF](#)

[Browse Figures](#)

[Citation Export](#)

<https://www.mdpi.com/1660-4601/12/4/4047>

Feb/2/2021



Atmospheric Environment
Volume 45, Issue 32, October 2011, Pages 5924–5933



Dust storm contributions to airborne particulate matter in Reykjavík, Iceland

Throstur Thorsteinsson ^a,  Guðrún Gísladóttir ^{a, b}, Joanna Bullard ^c, Grant McTainsh ^d

<https://doi.org/10.1016/j.atmosenv.2011.05.023>

[Get rights and content](#)

Abstract

Episodes of high levels of particulate matter (PM) in Reykjavík occur several times a year. The main sources of daily variation in PM are traffic or highly localized (e.g. construction) sources, however several episodes have been identified where these are not the cause. Examining PM₁₀ (diameter < 10 µm) levels around the time when dust storms are seen on satellite images, and verifying that the weather conditions are favorable for the duration of the high levels of PM (>50–100 µg m⁻³; 30-min average), demonstrates that dust storms are the source of these increased levels of PM₁₀. Since satellite coverage is sparse, visual

<https://www.sciencedirect.com/science/article/abs/pii/S1352231011005061>

Road Dust: A Common concern across Arctic communities

Alaska



Dust busting: Bush Alaska clouds with choking dust, and residents want to do something about it

Author: [Lisa Demer](#) Updated: August 21, 2017 Published August 13, 2017



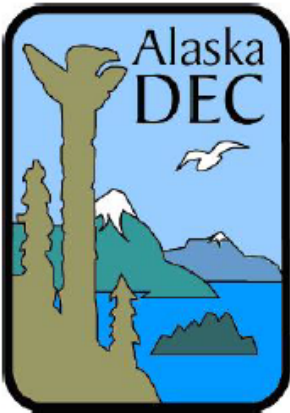
Dust clouds obscure traffic signs on Ridgcrest Drive in Bethel. (Lisa Demer / Alaska Dispatch News)

Facebook Twitter Email Telegram LinkedIn RSS Print A+ A-

<https://www.adn.com/alaska-news/rural-alaska/2017/08/13/dust-busting-bush-alaska-clouds-with-choking-dust-and-residents-want-to-do-something-about-it/>

A PRELIMINARY ASSESSMENT OF FUGITIVE DUST FROM ROADS IN EIGHT ALASKAN VILLAGES IN THE NORTHWEST ARCTIC BOROUGH

Project Report (2003-2005)



<https://dec.alaska.gov/air/>

Air Monitoring and Quality Assurance
Division of Air Quality
Department of Environmental Conservation
Anchorage, Alaska
July 2011



<https://www.youtube.com/watch?v=7Jghut7waR4>

Atmospheric Chemistry and Physics
An interactive open-access journal of the European Geosciences Union

EGU.eu | EGU Publications | EGU Highlight Articles | Contact | Imprint | Data

<https://doi.org/10.5194/acp-2018-973>
© Author(s) 2018. This work is distributed under the Creative Commons Attribution 4.0 License.

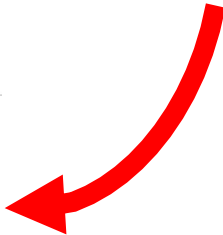


Research article

The impact of measures to reduce road dust, evaluated for a street canyon in Helsinki

Ana Stojiljkovic¹, Mari Kauhaniemi², Jaakko Kukkonen², Kaarle Kupiainen¹, Ari Karppinen², Bruce Rolstad Denby³, Anu Kousa⁴, Jarkko V. Niemi⁴, and Matthias Ketzel⁵
¹Finnish Environment Institute (SYKE), Helsinki, P.O.Box 140, FI-00251, Helsinki, Finland
²Finnish Meteorological Institute, Helsinki, P.O. Box 503, FI-00101, Helsinki

Finland



Iceland has the largest desert in Europe

Regular forecasts of dust in Iceland by the WMO

NORTHERN AFRICA-MIDDLE EAST-EUROPE (NA-ME-E) REGIONAL CENTER
WMO Sand and Dust Storm Warning Advisory and Assessment System (SDS-WAS)

WMO SDS WAS || Asia Regional Center || America Regional Center

Log in

HOME ABOUT US FORECAST & PRODUCTS PROJECTS & RESEARCH MATERIALS NEWS EVENTS CONTACT US

Dust forecasts

You are here: Home > Forecast & Products > Dust forecasts

Dust forecasts
by admin — last modified Aug 19, 2020 07:18

Ensemble forecast

Forecast comparison

Files Download

Forecast evaluation

Guidance for forecasters

Barcelona Dust forecast Center

Icelandic Dust Forecast

Probability Maps

Search

Search Site Search

Latest News

High Latitude Dust Workshop, 10-11 February 2021

Products include Surface, Total columnar and Aerosol Optical Depth

NORTHERN AFRICA-MIDDLE EAST-EUROPE (NA-ME-E) REGIONAL CENTER
WMO Sand and Dust Storm Warning Advisory and Assessment System (SDS-WAS)

WMO SDS WAS || Asia Regional Center || America Regional Center

Log in

HOME ABOUT US FORECAST & PRODUCTS PROJECTS & RESEARCH MATERIALS NEWS EVENTS CONTACT US

Dust forecasts

You are here: Home > Forecast & Products > Dust forecasts > Icelandic Dust Forecast

Icelandic Dust Forecast
by Francesco Benincasa — last modified Sep 23, 2020 11:16

Date: 2020-11-05 H+ 18

Dust optical depth:

Dust surface concentration:

Icelandic Dust Forecast - DREAM8 Dust Surface Concentration ($\mu\text{g}/\text{m}^3$)
Run: 00h 05 November 2020 Valid: 18h 05 November 2020 (H+18)

Search

Search Site Search

Latest News

High Latitude Dust Workshop, 10-11 February 2021
Jan 25, 2021

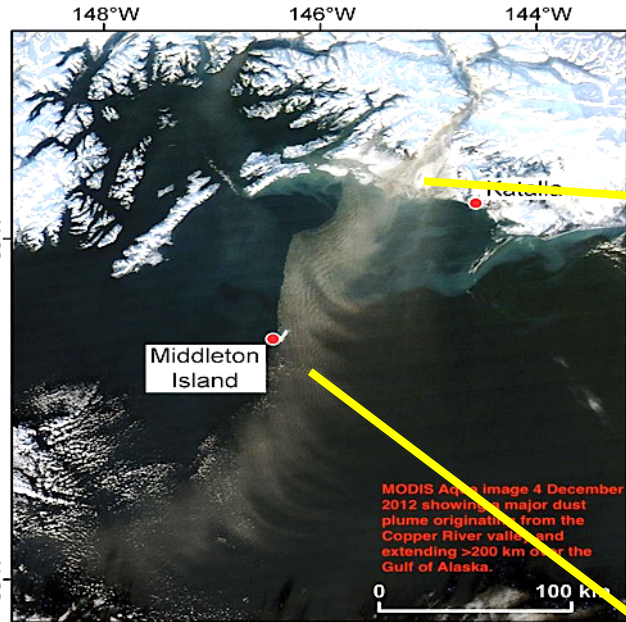
inDust 2021 webinars series
Dec 31, 2020

Model's upgrade in the Barcelona Dust Forecast Center
Dec 18, 2020

Upcoming Events

<https://sds-was.aemet.es/forecast-products/dust-forecasts/icelandic-dust-forecast>

Gulf of Alaska: An HLD environment in our backyard



Geophysical Research Letters

Oceans | Free Access

Glacial flour dust storms in the Gulf of Alaska: Hydrologic and meteorological controls and their importance as a source of bioavailable iron

John Crusius , Andrew W. Schroth, Santiago Gassó, Christopher M. Moy, Robert C. Levy, Myrna Gatica

First published: 18 March 2011 | <https://doi.org/10.1029/2010GL046573> | Citations: 82

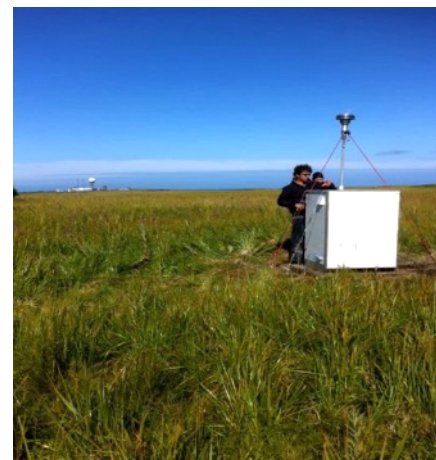
<https://doi.org/10.1029/2010GL046573>



A NASA IDS funded project, we installed a dust sampling station at Middleton Island, AK- 2011-2014 and an instrumentation in the Copper River Delta

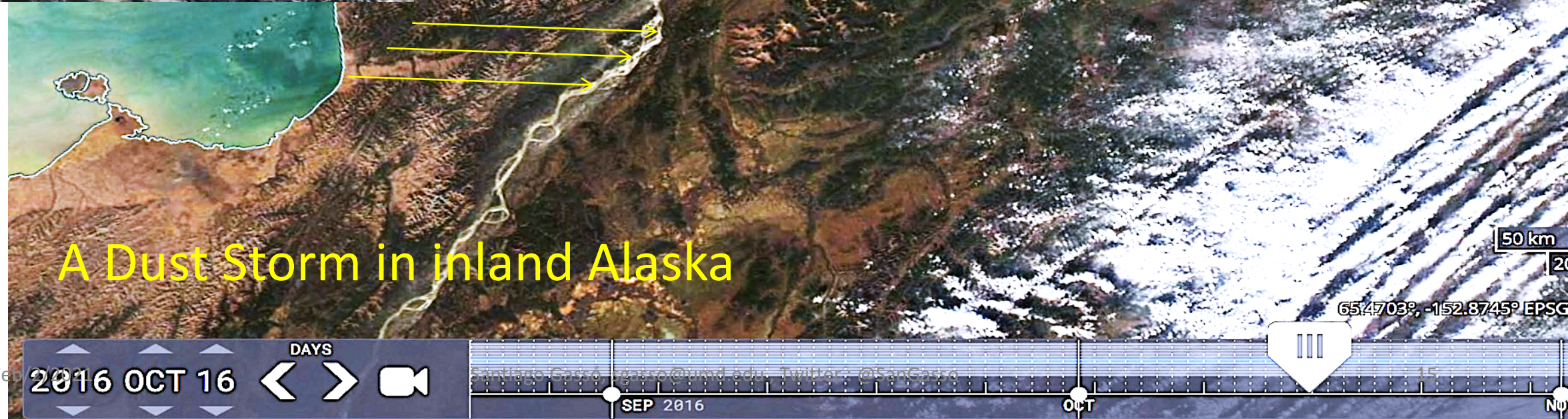
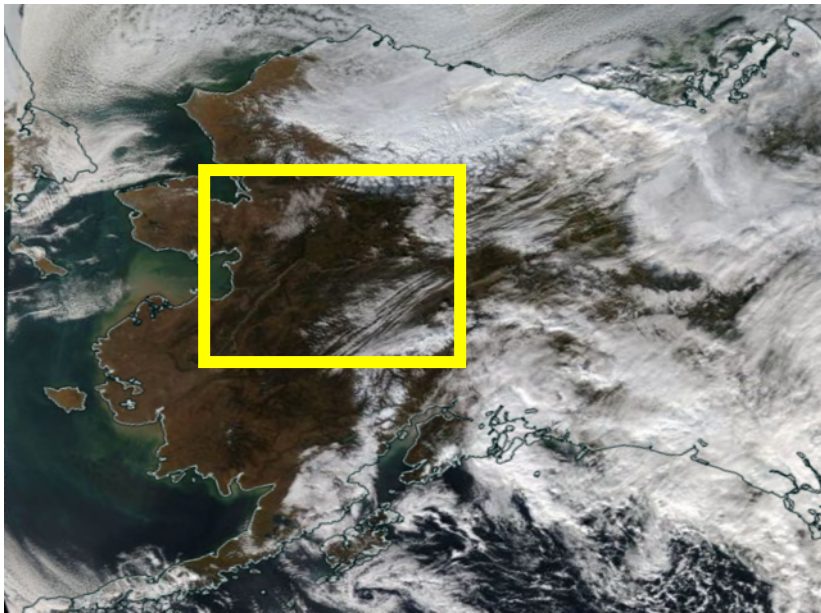
Middleton Island, off the coast of the Copper River Delta is an excellent site:

- There is significant infrastructure (airport, NWS site)
- Flat island with pristine marine air
- Downwind of a major source of dust



HLD activity is more apparent

More Satellites, More webcams in remote places



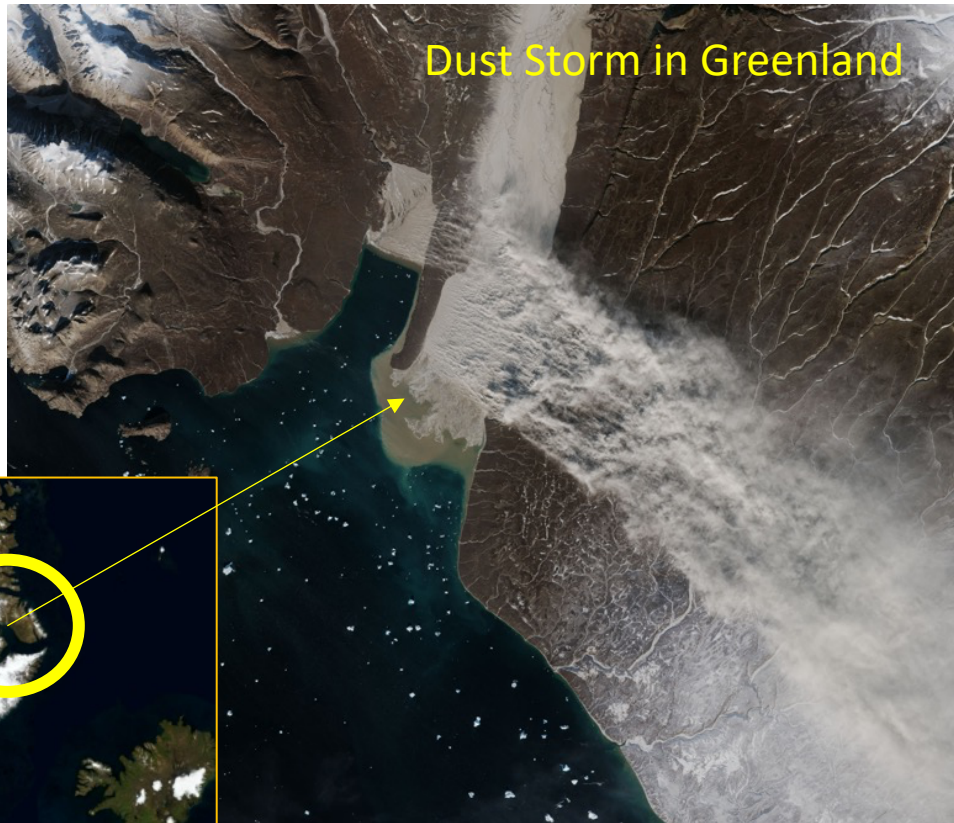
A Dust Storm in inland Alaska



HLD activity is more apparent

because better and more image archives, these events were found from my desktop in the office.....

Dust Activity near Glaciers in S. Georgia Island (Jan/27/2021)



<https://earthobservatory.nasa.gov/images/92891/glacier-flour-in-greenland-skies>

Feb/2/2021

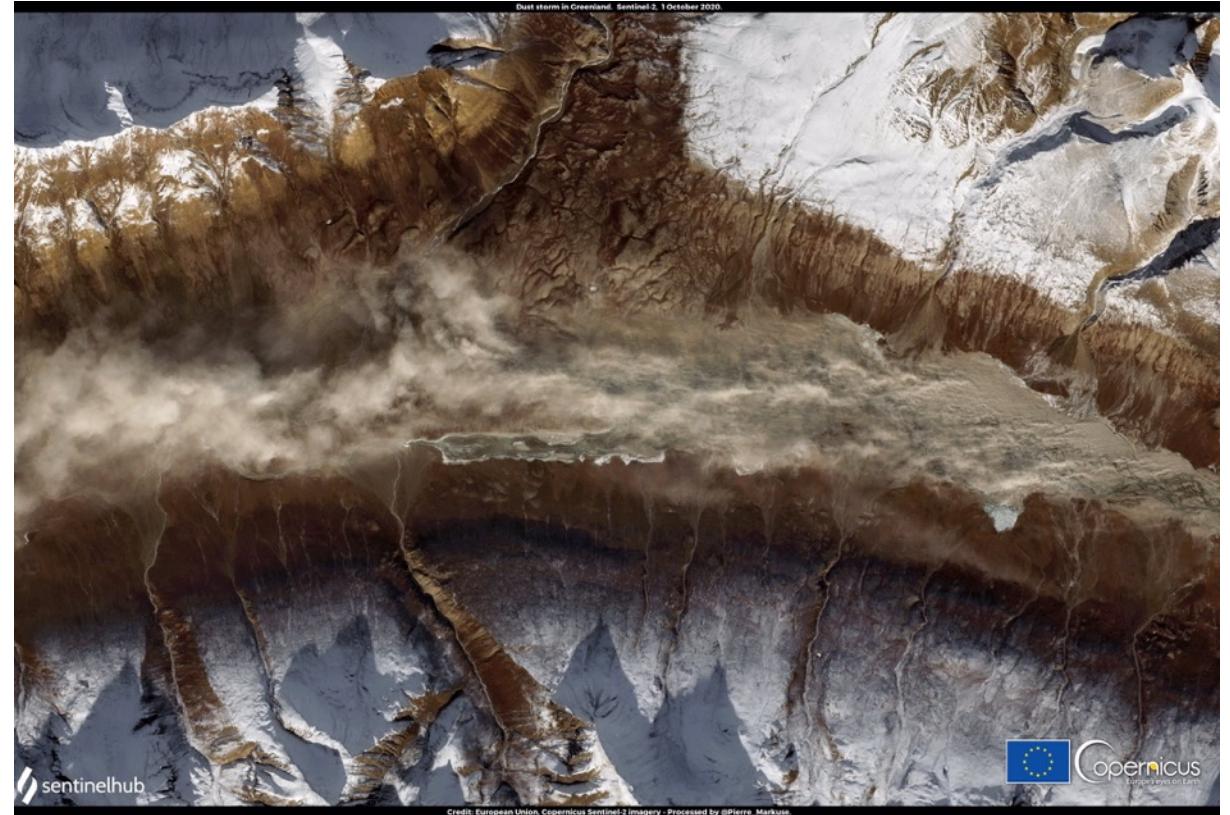


<https://twitter.com/SanGasso/status/1354412985322758151>

Santiago Gassó, sgasso@umd.edu , Twitter : @SanGasso

Current Issues Related to HLD

- Many basic questions are unanswered : where, when, how
- Hard to observe and model
- Very Multidisciplinary: questions in one discipline have answers rooted in a different discipline (for ex, the dust deposition over the ocean question)



Final Thoughts

There is more HLD to come!

because:

- Better observing networks
- Glaciers around the Arctic region are receding

Questions?

Contact info

E-mail: sgasso@umd.edu , Twitter : [@SanGasso](https://twitter.com/SanGasso), [#highlatitudedust](https://twitter.com/SanGasso)

